



IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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Attorney Docket No.: DAIN:447A
Date: October 6, 2000
Prior Application:
Examiner: C. H. Kelly
Art Unit: 1756

COMMISSIONER FOR PATENTS
Washington, D.C. 20231

Sir:

This is a request for filing a
[] Continuation [X] Divisional (parent not abandoned)
application under 37 C.F.R. §1.53(b), of pending prior application Serial
No. 09/025,249, filed February 18, 1998
for [Title]: LIQUID CRYSTALLINE COMPOUNDS AND PROCESS FOR PRODUCING THE SAME
by [Inventors]: Junichi HANNA, Masahiro FUNAHASHI, Komei KAFUKU, and
Kyoko KOGO

[X] A copy of the prior application is attached. This copy comprises
a true copy of the prior application as filed (specification,
claims, drawings, declaration). No amendments referred to in the
declaration (if any) filed to complete the prior application
introduced new matter therein.

[X] The filing fee is calculated below:

CLAIMS AS FILED IN THE PRIOR APPLICATION, LESS ANY CLAIMS
CANCELLED BY AMENDMENT BELOW

Basic Fee
\$710.00 (*35.00)

Total claims	19	-20 = 0	x \$18.00 (* 9.00)	=	-
Independent claims	1	- 3 = 0	x \$80.00 (*40.00)	=	-
Total Filing Fee.....				=	\$710.00

3. [X] A check in the amount of \$710.00 is enclosed (Ck# 13234).
THE COMMISSIONER IS HEREBY AUTHORIZED TO CHARGE ANY OTHER FEES
WHICH MAY BE REQUIRED OR CREDIT ANY OVERPAYMENT TO DEPOSIT ACCOUNT
NO. 16-0331. TWO DUPLICATE COPIES OF THIS FORM ARE ENCLOSED.

4. [] Cancel in this application original claims ____ of the prior
application before calculating the filing fee. At least one
original independent claim is retained for filing purposes.

5. [X] Amend the specification by inserting before the first line the
sentence:
--This is a [] Continuation [X] Division of application Serial No.
09/025,249 filed February 18, 1998.--

PLEASE ACCEPT THIS AS
AUTHORIZATION TO DEBIT
OR CREDIT FEES TO
DEP. ACCT. 16-0331
PARKHURST & WENDEL



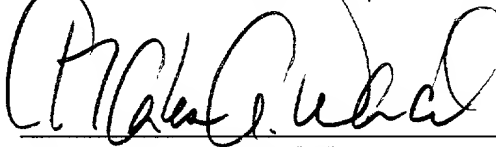
6. ☐ Transfer the drawings from the prior application to this application and abandon said prior application as of the filing date accorded this application. A duplicate copy of this form is enclosed for filing in the prior application file.
7. ☐ New ☐ Formal ☐ Informal drawings are enclosed: Fig(s) . .
8. ☒ Priority of foreign application(s) No. 49593/1997 filed February 19, 1997 in Japan is claimed under 35 U.S.C. §119.
- ☒ The certified copy was filed in prior application No. 09/025,249 on April 3, 1998.
- ☐ A certified copy of the above corresponding foreign application is filed herewith.
9. ☒ The prior application is assigned of record to DAI NIPPON PRINTING CO., LTD. Recorded at Reel 9115, Frame 0068.
10. ☒ The power of attorney in the prior application is to Roger W. Parkhurst, Registration No. 25,177 and Charles A. Wendel, Registration No. 24,453:
- ☒ a. The power appears in the original papers in the prior application.
- ☐ b. Since the power does not appear in the original papers, a copy of the power in the prior application is enclosed.
- ☒ c. Address all future communications to
- PARKHURST & WENDEL, L.L.P.
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Telephone: (703) 739-0220
11. ☒ A Preliminary Amendment is enclosed. Claims added by this Amendment are properly numbered consecutively beginning with the number next following the highest numbered original claim in the prior application.

12. ☒ An Information Disclosure Statement is enclosed.

*13. ☐ Small entity status was established in the parent application via a verified statement filed on _____.

Respectfully submitted,

PARKHURST & WENDEL, L.L.P.



Charles A. Wendel

Registration No. 24,453

(rev. 3/99)

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of

Junichi HANNA et al.

Prior

Group Art Unit: 1756

Serial No.: Rule 53(b) Div. of
Serial No. 09/025,249

Filed: February 18, 1998

Filed: October 6, 2000

Prior

Examiner: C. H. Kelly

For: LIQUID CRYSTALLINE COMPOUNDS AND PROCESS FOR
PRODUCING THE SAME

PRELIMINARY AMENDMENT

Commissioner for Patents
Washington, D.C. 20231

Sir:

Prior to examination of the above-identified application,
please enter the following specification and claim changes as noted
below:

IN THE SPECIFICATION:

Page 1, line 11, insert --an-- after "using".

IN THE CLAIMS:

Cancel claims 1, 3, and 7 without prejudice or disclaimer.

Claim 5, line 1, cancel "1 or".

Claim 9, line 1, cancel "7 or".

Claims 11 and 12, both line 2, cancel "1 or".

Claim 13, line 1, cancel "1 or".

Claim 14, line 2, cancel "1 or".

Claim 15, line 1, cancel "1"; and
line 2, cancel "or".

Claim 16, line 1, cancel "1 or".

Claims 17 and 18, both line 2, cancel "or 6".

Claim 19, line 1, cancel "or"; and
line 2, cancel "6".

Claims 20 and 21, both line 2, cancel "or 6".

Claim 22, line 1, cancel "or 6".

REMARKS

This application is a Rule 53(b) divisional application of U.S. Serial No. 09/025,249, filed February 18, 1998, now allowed.

Claims 1, 3, and 7 have been canceled and multiple claim dependencies have been eliminated where appropriate. The claims presented for examination are claims 2, 4 to 6, and 8 to 22.

The specification has been amended in the same manner as in the parent application and to identify the parent application.

Filed herewith is an Information Disclosure Statement listing all references cited during prosecution of the parent application.

Prompt examination of this application on the merits is respectfully solicited.

Respectfully submitted,

PARKHURST & WENDEL, L.L.P.

October 6, 2000
Date

Charles A. Wendel
Charles A. Wendel
Registration No. 24,453

CAW/ch
Attorney Docket No. DAIN:447A
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(rev. 3/3/00)

LIQUID CRYSTALLINE COMPOUNDS AND PROCESS FOR PRODUCING THE SAME

BACKGROUND OF THE INVENTION

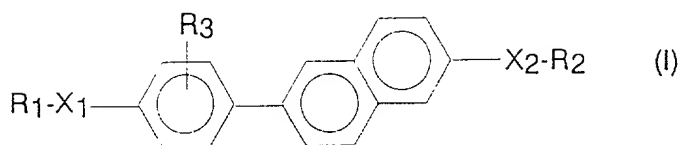
5 The present invention relates to liquid crystalline compounds and more particularly to novel crystalline compounds, which exhibit liquid crystallinity and, in addition, charge transport capability, and a process for producing the same.

10 Liquid crystalline compounds having various structures are known in the art and are widely used mainly as materials for information display devices using electro-optic effect based on the alignment effect of liquid crystal molecules attained by application of voltage. Further, application of liquid crystalline compounds to optical shutters, optical stops, modulating devices, lenses, light beam deflection/optical switches, phase diffraction gratings, optical
15 logic devices, memory devices and the like are under study. External stimulation by heat, electric field, magnetic field, pressure or the like results in transition of the alignment of liquid crystal molecules which enables optical properties and electric capacity to be easily changed. Sensors and measuring instruments, utilizing this property, for temperature, electric field/voltage,
20 infrared radiation, ultrasonic wave, flow rate/acceleration, gas or pressure have been studied in the art.

DISCLOSURE OF THE INVENTION

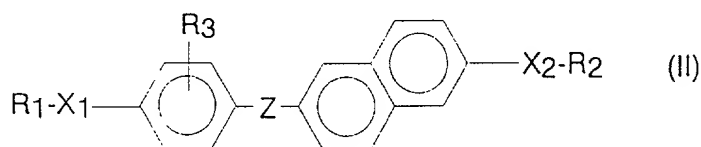
25 An object of the present invention is to provide liquid crystalline compounds having a novel structure and a process for producing the same.

 The above object can be attained by the following present invention. Specifically, according to one aspect of the present invention, there is provided a liquid crystalline compound represented by the following general formula (I):



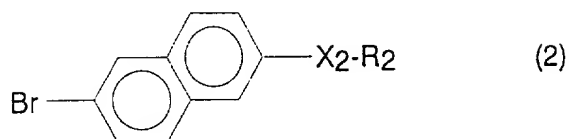
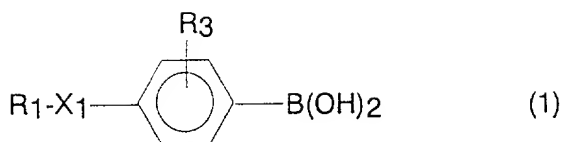
wherein R_1 and R_2 each independently represent a straight-chain, branched or cyclic, saturated or unsaturated hydrocarbon group having 1 to 22 carbon atoms and may be attached directly to the aromatic ring without through X_1 or X_2 ; R_3 represents a hydrogen atom, a cyano group, a nitro group, a fluorine atom, or a methyl group; and X_1 and X_2 each independently represent an oxygen atom, a sulfur atom, or a -CO- , -OCO- , -COO- , -N=CH- , -CONH- , -NH- , -NHCO- , or $\text{-CH}_2\text{-}$ group.

According to another aspect of the present invention, there is provided a liquid crystalline compound represented by the following general formula (II):



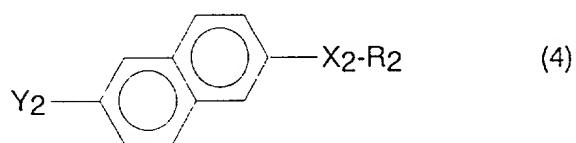
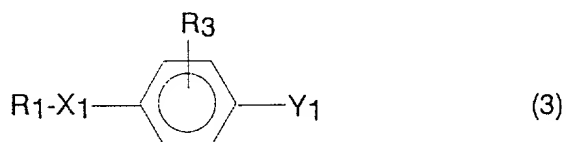
wherein R_1 and R_2 each independently represent a straight-chain, branched or cyclic, saturated or unsaturated hydrocarbon group having 1 to 22 carbon atoms and may be attached directly to the aromatic ring without through X_1 or X_2 ; R_3 represents a hydrogen atom, a cyano group, a nitro group, a fluorine atom, or a methyl group; X_1 and X_2 each independently represent an oxygen atom, a sulfur atom, or a -CO- , -OCO- , -COO- , -N=CH- , -CONH- , -NH- , -NHCO- , or $\text{-CH}_2\text{-}$ group; and Z represents a -COO- , -OCO- , -N=N- , -CH=N- , $\text{-CH}_2\text{S-}$, -CH=CH- , or $\text{-C}\equiv\text{C-}$ group.

According to still another aspect of the present invention, there is provided a process for producing the liquid crystalline compound represented by the general formula (I), comprising the step of reacting a compound represented by the following general formula (1) with a compound represented by the following general formula (2):



wherein R_1 , R_2 , R_3 , X_1 , and X_2 are as defined above.

According to a further aspect of the present invention, there is provided a process for producing the liquid crystalline compound represented by the general formula (II), comprising the step of reacting a compound represented by the following general formula (3) with a compound represented by the following general formula (4):



wherein R_1 , R_2 , R_3 , X_1 , and X_2 are as defined above; and Y_1 and Y_2 are respectively groups which are reacted with each other to form a -COO- , -OCO- , -N=N- , -CH=N- , $\text{-CH}_2\text{S-}$, -CH=CH- , or $\text{-C}\equiv\text{C-}$ group.

The present invention can provide novel liquid crystalline compounds having not only liquid crystallinity but also charge transport capability. The novel liquid crystalline compounds can be used in applications, where the conventional liquid crystalline compounds are used, and, in addition, are useful as materials for optical sensors, electroluminescence devices,

photoconductors, space light modulating devices, thin film transistors, other sensors and the like, utilizing the charge transfer capability. In particular, some of the liquid crystalline compounds of the present invention have both electron transport capability and hole transport capability and, when mixed with a fluorescent material in order to use them as a material for an electroluminescence device, can provide luminescence.

The present invention will be described in more detail with reference to the following preferred embodiments.

Example 1

50 ml of THF (tetrahydrofuran) was added to 2.91 g (0.12 mol) of metallic magnesium, and the mixture was stirred. 100 ml of a solution of 26.89 g (0.1 mol) of p-octylbromobenzene in THF was added dropwise thereto, and the mixture was heated. After the initiation of the reaction was confirmed, the mixture was refluxed for one hr. The mixture was cooled to -78°C , 12.46 g (0.12 mol) of trimethylboric acid was added dropwise thereto, and the mixture was stirred for 30 min. The temperature was returned to room temperature, followed by stirring for additional one hr. Dilute hydrochloric acid was added thereto, and the mixture was stirred for one hr. The aqueous layer was extracted with ether, and the oil layer was washed with water and then with an aqueous sodium hydrogencarbonate. The oil layer was then dried over sodium sulfate, the solvent was removed by distillation, and the resultant crude product was purified by chromatography on silica gel to give p-octylphenylboric acid.

The above compound exhibited the following peaks in NMR spectrum:

^1H NMR (CDCl_3)

$\delta = 8.14$ (2H, d, $J = 8.6$ Hz), 7.31 (2H, d, $J = 7.9$ Hz), 2.68 (2H, t, $J = 7.3$ Hz), 1.50 - 1.80 (4H, m), 1.20 - 1.40 (8H, m), 0.88 (3H, t, $J = 7.6$ Hz)

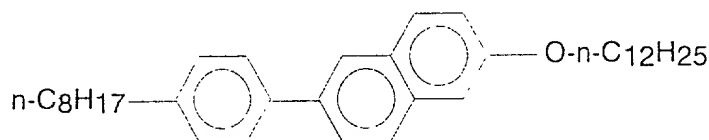
22.29 g (0.1 mol) of 2-bromo-6-naphthol, 11.22 g (0.2 mol) of potassium hydroxide, and 32.36 g (0.13 mol) of 1-bromododecane were dissolved in ethanol (300 ml), and the solution was refluxed for 8 hr. Thereafter, water was added thereto, the mixture was cooled, and the resultant precipitate was collected by filtration and washed with a sodium hydroxide solution and then with water. The crude product thus obtained was recrystallized from ethyl acetate to give 2-bromo-6-dodecyloxynaphthalene.

The above compound exhibited the following peaks in NMR spectrum:

^1H NMR (CDCl_3)

δ = 7.89 (1H, d, J = 2.0 Hz), 7.62 (1H, d, J = 8.9 Hz), 7.57 (1H, d, J = 8.9 Hz), 7.47 (1H, dd, J_1 = 2.0 Hz, J_2 = 8.9 Hz), 7.15 (1H, dd, J_1 = 2.6 Hz, J_2 = 8.9 Hz), 7.07 (1H, d, J = 2.6 Hz), 4.04 (2H, t, J = 6.6 Hz), 1.84 (2H, quint, J = 6.6 Hz), 1.40-1.50 (4H, m), 1.17-1.40 (14H, m), 0.88 (3H, t, J = 6.8 Hz)

2.01 g (0.01 mol) of p-octylphenylboric acid, 3.91 g (0.01 mol) of 2-bromo-6-dodecyloxynaphthalene, and $\text{Pd}(\text{PPh}_3)_4$ (0.0005 mol) were dissolved in dimethoxyethane (50 ml), a 10% aqueous potassium carbonate solution (40 ml) was added thereto, and the mixture was refluxed for one hr. After cooling, the resultant precipitate was collected by filtration and washed with water and ethanol. The crude product thus obtained was recrystallized from hexane to give a compound represented by the following formula:



The above compound exhibited the following peaks in NMR spectrum:

^1H NMR (CDCl_3)

δ = 7.94 (1H, d, J = 1.3 Hz), 7.77 (2H, d, J = 8.6 Hz), 7.69 (1H, dd, J_1 = 1.7 Hz, J_2 = 8.6 Hz), 7.62 (2H, d, J = 8.3 Hz), 7.28 (2H, d, J = 8.3 Hz), 7.16 (1H, dd, J_1 = 2.6 Hz, J_2 = 8.3 Hz), 7.14 (1H, s), 4.08 (2H, t, J = 6.6 Hz), 2.66 (2H, t, J = 7.3 Hz), 1.86 (2H, quint, J = 6.8 Hz), 1.40-1.70 (4H, m), 1.20-1.70 (26H, m), 0.89 (3H, t, J = 5.6 Hz), 0.88 (3H, t, J = 6.9 Hz)

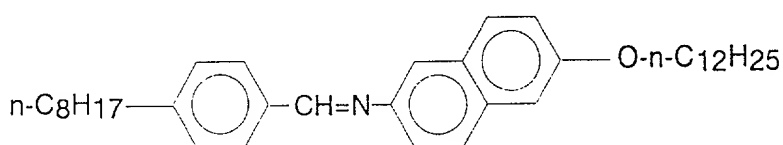
The above compound had the following phase transition temperatures.

Crystal - 79.3°C - SmX_1 - 100.4°C - SmX_2 - 121.3°C - Iso. (X_1 and X_2 were unidentified)

The charge mobility of the above compound was $10^{-3} \text{ cm}^2/\text{Vs}$ for both electron and hole.

Example 2

2.18 g (0.01 mol) of p-octylbenzaldehyde and 3.28 g (0.01 mol) of 2-amino-6-dodecyloxynaphthalene were dissolved in ethanol (30 ml), and the solution was heated at 70°C for 2 hr with stirring. After the reaction, the mixture was cooled to room temperature, and the precipitated solid was collected by filtration and recrystallized from ethanol to give a compound represented by the following formula. This compound had the same properties as the compound prepared in Example 1.



Example 3

The procedure of Example 1 was repeated to prepare liquid crystalline compounds represented by the general formula (I) wherein R_1 , R_2 , R_3 , X_1 , and X_2 represent respective groups specified in Table 1. All the liquid crystalline compounds thus obtained had the same properties as the liquid crystalline compound prepared in Example 1.

Table 1

Ex.	R_1	R_2	R_3	X_1	X_2
3-1	$\text{CH}_3(\text{CH}_2)_8$	$(\text{CH}_2)_9\text{CH}_3$	H	CH_2	O
3-2	$\text{CH}_3(\text{CH}_2)_5$	$(\text{CH}_2)_7\text{CH}_3$	3'-CN	CH_2	S
3-3	$\text{CH}_3(\text{CH}_2)_{15}$	$(\text{CH}_2)_3\text{CH}_3$	2'-F	O	O
3-4	$\text{CH}_3\text{CH}_2\text{C}^*\text{H}(\text{CH}_3)\text{CH}_2$	$(\text{CH}_2)_5\text{CH}_3$	3'-NO ₂	S	O
3-5	$\text{CH}_3(\text{CH}_2)_8$	$\text{CH}_3(\text{CH}_2)_8$	H	CH_2	CH_2
3-6	$\text{C}_5\text{H}_{11}\text{CFCH}_3$	$\text{C}_{10}\text{H}_{21}$	H	COO	O
3-7	C_8H_{17}	C_5H_{11}	2'-F, 3'-F	O	-

Example 4

The procedure of Example 2 was repeated to prepare liquid crystalline compounds represented by the general formula (II) wherein R_1 , R_2 , R_3 , X_1 , X_2 , and Z represent respective groups specified in Table 2. All the liquid crystalline compounds thus obtained had the same properties as the liquid crystalline compound prepared in Example 2.

Table 2

Ex.	R_1	R_2	R_3	X_1	X_2	Z
4-1	$\text{CH}_3(\text{CH}_2)_8$	$(\text{CH}_2)_9\text{CH}_3$	2',3'-F	CH_2	O	$\text{CH}=\text{N}$
4-2	$\text{CH}_3(\text{CH}_2)_5$	$(\text{CH}_2)_7\text{CH}_3$	3'-CN	CH_2	S	COO
4-3	$\text{CH}_3\text{CH}_2\text{C}^*\text{H}(\text{CH}_3)\text{CH}_2$	$(\text{CH}_2)_5\text{CH}_3$	3'-NO ₂	CH_2	O	$\text{CH}=\text{C}$ H
4-4	$\text{CH}_3(\text{CH}_2)_{15}$	$(\text{CH}_2)_3\text{CH}_3$	H	O	O	$\text{C}\equiv\text{C}$
4-5	$\text{CH}_3(\text{CH}_2)_8$	$\text{CH}_3(\text{CH}_2)_8$	H	CH_2	CH_2	$\text{N}=\text{N}$
4-6	C_4H_9	$\text{C}_6\text{H}_5\text{-C}_4\text{H}_9$	H	-	CO O	OCO
4-7	$\text{C}_2\text{H}_5\text{CH}(\text{CH}_3)\text{CH}_2$	$\text{C}_{10}\text{H}_{21}$	H	OOC	O	CO
4-8	$\text{C}_6\text{H}_{13}\text{OC}_6\text{H}_5$	H	H	$\text{CH}=\text{N}$	-	$\text{CH}=\text{N}$

Example 5

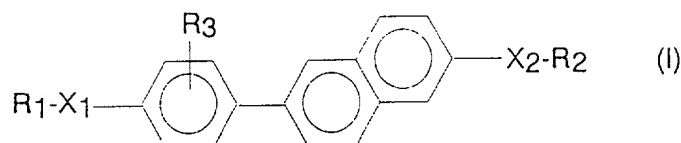
Two glass substrates each having an ITO electrode (surface electric resistance: 100-200 Ω/\square) provided by vacuum film formation were laminated onto each other so that the ITO electrodes faced each other while providing a gap (about 2 μm) therebetween using spacer particles, thereby preparing a cell. The naphthalene compound liquid crystal (2-(4'-octylphenyl)-6-dodecyloxynaphthalene, Crystal - 79°C - SmX - 121°C - Iso.) prepared in Example 1 was mixed with 1% by mole of a luminescent dye (3-(2-benzothiazolyl)-7-(diethylamino)-2H-1-benzopyran-2-one (manufactured by Nihon Kanko Shikiso Kenkyusho (Japan Photosensitive Dye Laboratory), oscillating wavelength: 507-585 nm), and the mixture was poured at 125°C into the cell. An d.c. electric field of 250 V was applied to the cell in a dark place.

As a result, light emission derived from the fluorescent wavelength of the fluorescent dye was observed.

As described above, the present invention can provide novel liquid crystalline compounds having not only liquid crystallinity but also charge transport capability. The novel liquid crystalline compounds can be used in applications, where the conventional liquid crystalline compounds are used, and, in addition, are useful as materials for optical sensors, electroluminescence devices, photoconductors, space light modulating device, thin film transistors, other sensors and the like, utilizing the charge transfer capability. In particular, some of the liquid crystalline compounds of the present invention have both electron transport capability and hole transport capability and, when mixed with a fluorescent material in order to use it as a material for an electroluminescence device, can provide luminescence.

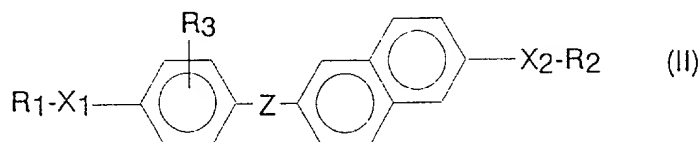
CLAIMS

1. A liquid crystalline compound represented by the following general formula (I):



wherein R_1 and R_2 each independently represent a straight-chain, branched or cyclic, saturated or unsaturated hydrocarbon group having 1 to 22 carbon atoms and may be attached directly to the aromatic ring without through X_1 or X_2 ; R_3 represents a hydrogen atom, a cyano group, a nitro group, a fluorine atom, or a methyl group; and X_1 and X_2 each independently represent an oxygen atom, a sulfur atom, or a $-CO-$, $-OCO-$, $-COO-$, $-N=CH-$, $-CONH-$, $-NH-$, $-NHCO-$, or $-CH_2-$ group.

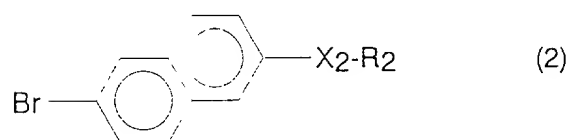
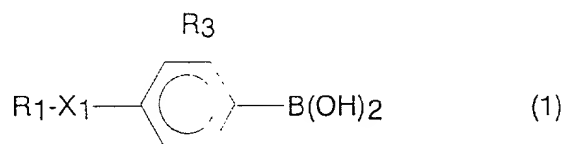
2. A liquid crystalline compound represented by the following general formula (II):



wherein R_1 and R_2 each independently represent a straight-chain, branched or cyclic, saturated or unsaturated hydrocarbon group having 1 to 22 carbon atoms and may be attached directly to the aromatic ring without through X_1 or X_2 ; R_3 represents a hydrogen atom, a cyano group, a nitro group, a fluorine atom, or a methyl group; X_1 and X_2 each independently represent an oxygen atom, a sulfur atom, or a $-CO-$, $-OCO-$, $-COO-$, $-N=CH-$, $-CONH-$, $-NH-$, $-NHCO-$, or $-CH_2-$ group; and Z represents a $-COO-$, $-OCO-$, $-N=N-$, $-CH=N-$, $-CH_2S-$, $-CH=CH-$, or $-C\equiv C-$ group.

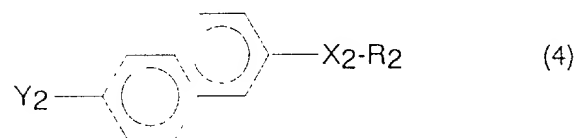
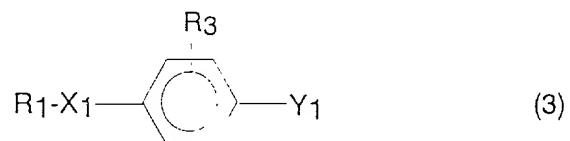
3. A process for producing the liquid crystalline compound according to

claim 1, comprising the step of reacting a compound represented by the following general formula (1) with a compound represented by the following general formula (2):



wherein R_1 , R_2 , R_3 , X_1 , and X_2 are as defined above.

4. A process for producing the liquid crystalline compound according to claim 2, comprising the step of reacting a compound represented by the following general formula (3) with a compound represented by the following general formula (4):



wherein R_1 , R_2 , R_3 , X_1 , and X_2 are as defined above; and Y_1 and Y_2 are respectively groups which are reacted with each other to form a -COO- , -OCO- , -N=N- , -CH=N- , $\text{-CH}_2\text{S-}$, -CH=CH- , or $\text{-C}\equiv\text{C-}$ group.

5. The liquid crystalline compound according to claim 1 or 2, which has charge transport capability.

6. The liquid crystalline compound according to claim 5, which has a liquid crystal phase comprising at least a smectic phase.

7. The liquid crystalline compound according to claim 1, wherein R_3 represents a hydrogen or fluorine atom and X_1 and X_2 each independently represent an oxygen atom or a $-CH_2-$, $-CO-$, $-OCO-$, $-COO-$, or $-N=CH-$ group.

8. The liquid crystalline compound according to claim 2, wherein R_3 represents a hydrogen or fluorine atom and X_1 and X_2 each independently represent an oxygen atom or a $-CH_2-$, $-CO-$, $-OCO-$, $-COO-$, or $-N=CH-$ group.

9. The liquid crystalline compound according to claim 7 or 8, which has charge transport capability.

10. The liquid crystalline compound according to claim 9, which has a liquid crystal phase comprising at least a smectic phase.

11. An image display device comprising the compound according to claim 1 or 2 in a drive path.

12. An electroluminescence device comprising the compound according to claim 1 or 2 in a drive path.

13. A photoconductor comprising the compound according to claim 1 or 2 in a drive path.

14. A space light modulating device comprising the compound according to claim 1 or 2 in a drive path.

15. A thin film transistor comprising the compound according to claim 1 or 2 in a drive path.

16. A sensor comprising the compound according to claim 1 or 2 in a drive path.

17. An image display device comprising the compound according to claim 5 or 6 in a drive path.

18. An electroluminescence device comprising the compound according to claim 5 or 6 in a drive path.

19. A photoconductor comprising the compound according to claim 5 or 6 in a drive path.

20. A space light modulating device comprising the compound according

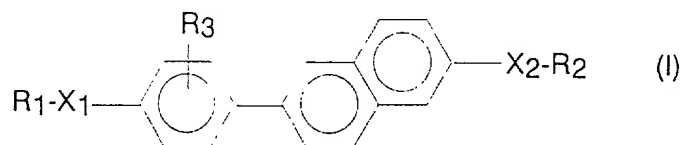
to claim 5 or 6 in a drive path.

21. A thin film transistor comprising the compound according to claim 5 or 6 in a drive path.

22. A sensor comprising the compound according to claim 5 or 6 in a drive path.

ABSTRACT

A liquid crystalline compound having a novel structure and a process for producing the same are provided. The liquid crystalline compound is represented by the following general formula (I):



wherein R_1 and R_2 each independently represent a straight-chain, branched or cyclic, saturated or unsaturated hydrocarbon group having 1 to 22 carbon atoms and may be attached directly to the aromatic ring without through X_1 or X_2 ; R_3 represents a hydrogen atom, a cyano group, a nitro group, a fluorine atom, or a methyl group; and X_1 and X_2 each independently represent an oxygen atom, a sulfur atom, or a $-CO-$, $-OCO-$, $-COO-$, $-N=CH-$, $-CONH-$, $-NH-$, $-NHCO-$, or $-CH_2-$ group.

APPLICATION FOR UNITED STATES PATENT

Declaration and Power of Attorney

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name; that

I verily believe that I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural inventors are named below) of the subject matter which is claimed and for which a patent is sought on the invention entitled: _____
"LIQUID CRYSTALLINE COMPOUNDS AND PROCESS FOR PRODUCING THE SAME"

described and claimed in the specification:

Check one

*a. ☐ attached hereto.

b. ☒ filed on February 18, 1998 as Application Serial No. 09/025,249 and amended on _____;
(if applicable)

I hereby state that I have reviewed and understand the contents of the above-identified application, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information of which I am aware which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a). Under Title 35 U.S. Code §119, the priority benefits of the following foreign application(s) filed within one year prior to this application are hereby claimed:

Japanese Patent Application No. 49593/1997 filed on February 19, 1997

The following applications for patent or inventor's certificate on this invention were filed in countries foreign to the United States of America either (a) more than one year prior to this application, or (b) before the filing date of the above-named foreign priority application(s):

2. If there are no corresponding applications,
insert "NONE".

I hereby appoint the following as my attorneys of record with full power of substitution and revocation to prosecute this application and to transact all business in the Patent Office:

Roger W. Parkhurst, Reg. No. 25,177; Charles A. Wendel, Reg. No. 24,453; and/or Lawrence D. Eisen, Reg. No. 41,009

**ALL CORRESPONDENCE IN CONNECTION WITH THIS APPLICATION SHOULD BE SENT
TO PARKHURST & WENDEL, L.L.P., 1421 Prince Street, Suite 210, Alexandria, Virginia 22314-2805
Telephone: (703) 739-0220.**

I hereby declare that I have reviewed and understand the contents of this Declaration, and that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

3 Typewritten Full Name of
Sole or First Inventor

Junichi

HANNA

Given Name

Middle Initial

Family Name

*4 Inventor's Signature

Junichi

Hanna

5 Date of Signature

April

9,

1998

Month

Day

Year

6 Residence

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Tokyo-To

Japan

7 Citizenship

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8 Post Office Address

c/o Dai Nippon Printing Co., Ltd., 1-1, Ichigaya-Kaga-

(Insert complete mailing
address, including country)

Cho 1-Chome, Shinjuku-Ku, Tokyo-To, Japan

*This form may be executed only when attached to the specification (including claims) at the end thereof if Box a. is checked.

**Note to the Inventor. Please sign name on line 4 exactly as it appears in line 3 and insert the actual date of signing on line 5.

IF THERE IS MORE THAN ONE INVENTOR USE PAGE 2 AND PLACE AN "X" HERE ☒

PAGE 2 OF U.S.A. DECLARATION FORM
(Discar page in a sole inventor application)

3 Typewritten Full Name of Second Joint Inventor (if any)		Masahiro		FUNAHASHI	
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3 Typewritten Full Name of Fifth Joint Inventor (if any)					
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*4 Inventor's Signature					
5 Date of Signature					
		Month	Day	Year	
6 Residence					
		City	State or Province	Country	
7 Citizenship					
8 Post Office Address (Insert complete mailing address, including country)					

*Note to Inventors: Please sign name on line 4 exactly as it appears in line 3 and insert the actual date of signing on line 5.

**This form may be executed only when attached to the first page of the Declaration and Power of Attorney form and the specification (including claims) of the application to which it pertains.